

Inventors: Nakamura, et al.
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Amendments to the Claims

This listing of claims will replace all prior versions, and listing, of claims in the application.

Listing of Claims

1 (Original). A twisted nematic liquid crystal display device for conducting a display operation in Normally Black mode, the liquid crystal display device comprising

a liquid crystal cell including two substrates and a liquid crystal layer sandwiched between the two substrates, and

two polarizers facing each other with the liquid crystal cell interposed between themselves,

wherein the liquid crystal display device further includes

a first optical compensator, which is provided between one of the two polarizers and the liquid crystal cell so as to compensate for the wavelength dependence of the angle of rotation of polarized light passing through the liquid crystal layer in a black display state, and

a second optical compensator, which is provided between the first optical compensator and that polarizer so as to compensate for the wavelength dependence of the ellipticity of the polarized light passing through the liquid crystal layer in the black display state.

2 (Original). The liquid crystal display device of claim 1, wherein if the polarized light passes through the liquid crystal layer in the black display state, the first optical compensator has functions of hardly changing the polarization direction of a linearly polarized light ray having a particular wavelength but substantially aligning the elliptical major-axis direction of an elliptically polarized light ray, having a wavelength that is shorter or longer than the particular wavelength, with the polarization direction of the linearly polarized light ray.

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3 (Original). The liquid crystal display device of claim 2, wherein if the polarized light passes through the liquid crystal layer in the black display state, the second optical compensator has functions of passing the linearly polarized light ray having the particular wavelength as it is but changing the elliptically polarized light ray, having the wavelength that is shorter or longer than the particular wavelength, into a substantially linearly polarized light ray.

4 (Original). The liquid crystal display device of claim 2, wherein the first optical compensator exhibits a retardation, and has a slow axis, within a plane that is defined parallel to the liquid crystal layer, and

wherein the slow axis and the wavelength dispersion characteristic of in-plane retardations of the first optical compensator are adjusted into predetermined ones according to the wavelength dependence of the angle of rotation of the polarized light passing through the liquid crystal layer in the black display state, thereby allowing the first optical compensator to perform the functions.

5 (Original). The liquid crystal display device of claim 3, wherein the second optical compensator exhibits a retardation, and has a slow axis, within a plane that is defined parallel to the liquid crystal layer, and

wherein the slow axis and the wavelength dispersion characteristic of in-plane retardations of the second optical compensator are adjusted into predetermined ones according to the wavelength dependence of the ellipticity of the polarized light passing through the liquid crystal layer in the black display state, thereby allowing the second optical compensator to perform the functions.

6 (Original). The liquid crystal display device of claim 2, wherein the particular wavelength falls within the range of 450 nm to 600 nm.

7 (Original). The liquid crystal display device of claim 1, wherein the liquid crystal layer has a front retardation $\Delta n \cdot d$ of 390 nm to 550 nm in the black display state.

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8 (Original). The liquid crystal display device of claim 1, wherein the first optical compensator exhibits a retardation, and has a slow axis, within a plane that is defined parallel to the liquid crystal layer, and

wherein the first optical compensator has an in-plane retardation Re_1 of 75 nm to 210 nm, and

wherein the slow axis of the first optical compensator defines an angle of 85 degrees to 95 degrees with respect to orientation directions of liquid crystal molecules in the black display state, the liquid crystal molecules being included in the liquid crystal layer and located near one of the two substrates, which is closer to the first optical compensator.

9 (Original). The liquid crystal display device of claim 1, wherein the second optical compensator exhibits a retardation, and has a slow axis, within a plane that is defined parallel to the liquid crystal layer, and

wherein the in-plane retardation Re_2 of the second optical compensator and the front retardation $\Delta n \cdot d$ of the liquid crystal layer satisfy the inequality

$$0.44 \cdot (\Delta n \cdot d) + 50 \leq Re_2 \leq 0.44 \cdot (\Delta n \cdot d) + 80, \text{ and}$$

wherein the slow axis of the second optical compensator defines an angle of 42 degrees to 48 degrees with respect to orientation directions of liquid crystal molecules in the black display state, the liquid crystal molecules being included in the liquid crystal layer and located near one of the two substrates, which is closer to the first optical compensator.

10 (Original). The liquid crystal display device of claim 1, wherein the first and second optical compensators are located closer to a viewer than the liquid crystal cell is.

11 (Original). The liquid crystal display device of claim 1, wherein the first and second optical compensators are located more distant from a viewer than the liquid crystal cell is.

12 (Original). The liquid crystal display device of claim 1, wherein the first optical compensator is a phase film with uniaxial optical anisotropy.

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13 (Original). The liquid crystal display device of claim 1, wherein the second optical compensator is a phase film with uniaxial optical anisotropy.

14 (Original). The liquid crystal display device of claim 1, wherein the transmission axis of the other polarizer is either substantially parallel or substantially perpendicular to the orientation directions of the liquid crystal molecules in the black display state, the liquid crystal molecules being included in the liquid crystal layer and located near the substrate that is closer to the first optical compensator.

15 (Original). The liquid crystal display device of claim 1, wherein the liquid crystal layer has a twist angle of 85 degrees to 95 degrees.

16 (Withdrawn). A twisted nematic liquid crystal display device for conducting a display operation in Normally Black mode, the liquid crystal display device comprising

a liquid crystal cell including two substrates and a liquid crystal layer sandwiched between the two substrates, and

two polarizers facing each other with the liquid crystal cell interposed between themselves,

wherein the liquid crystal display device further includes

a first optical compensator between one of the two polarizers and the liquid crystal cell, and

a second optical compensator between the first optical compensator and that polarizer,

wherein if polarized light passes through the liquid crystal layer in a black display state, the first optical compensator has functions of hardly changing the polarization direction of a linearly polarized light ray having a particular wavelength but substantially aligning the elliptical major-axis direction of an elliptically polarized light ray, having a wavelength that is shorter or longer than the particular wavelength, with the polarization direction of the linearly polarized light ray, while the second optical compensator has functions of passing the linearly polarized light ray having the

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particular wavelength as it is but changing the elliptically polarized light ray, having the wavelength that is shorter or longer than the particular wavelength, into a substantially linearly polarized light ray.

17 (Withdrawn). The liquid crystal display device of claim 16, wherein the first optical compensator exhibits a retardation, and has a slow axis, within a plane that is defined parallel to the liquid crystal layer, and

wherein the slow axis and the wavelength dispersion characteristic of in-plane retardations of the first optical compensator are adjusted into predetermined ones according to the wavelength dependence of the angle of rotation of the polarized light passing through the liquid crystal layer in the black display state, thereby allowing the first optical compensator to perform the functions.

18 (Withdrawn). The liquid crystal display device of claim 16, wherein the second optical compensator exhibits a retardation, and has a slow axis, within a plane that is defined parallel to the liquid crystal layer, and

wherein the slow axis and the wavelength dispersion characteristic of in-plane retardations of the second optical compensator are adjusted into predetermined ones according to the wavelength dependence of the ellipticity of the polarized light passing through the liquid crystal layer in the black display state, thereby allowing the second optical compensator to perform the functions.

19 (Withdrawn). The liquid crystal display device of claim 16, wherein the particular wavelength falls within the range of 450 nm to 600 nm.

20 (Withdrawn). The liquid crystal display device of claim 16, wherein the liquid crystal layer has a front retardation $\Delta n \cdot d$ of 390 nm to 550 nm in the black display state.

21 (Withdrawn). The liquid crystal display device of claim 16, wherein the first optical compensator exhibits a retardation, and has a slow axis, within a plane that is defined parallel to the liquid crystal layer, and

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wherein the first optical compensator has an in-plane retardation Re_1 of 75 nm to 210 nm, and

wherein the slow axis of the first optical compensator defines an angle of 85 degrees to 95 degrees with respect to orientation directions of liquid crystal molecules in the black display state, the liquid crystal molecules being included in the liquid crystal layer and located near one of the two substrates, which is closer to the first optical compensator.

22 (Withdrawn). The liquid crystal display device of claim 16, wherein the second optical compensator exhibits a retardation, and has a slow axis, within a plane that is defined parallel to the liquid crystal layer, and

wherein the in-plane retardation Re_2 of the second optical compensator and the front retardation $\Delta n \cdot d$ of the liquid crystal layer satisfy the inequality $0.44 \cdot (\Delta n \cdot d) + 50 \leq Re_2 \leq 0.44 \cdot (\Delta n \cdot d) + 80$, and

wherein the slow axis of the second optical compensator defines an angle of 42 degrees to 48 degrees with respect to orientation directions of liquid crystal molecules in the black display state, the liquid crystal molecules being included in the liquid crystal layer and located near one of the two substrates, which is closer to the first optical compensator.

23 (Withdrawn). The liquid crystal display device of claim 16, wherein the first and second optical compensators are located closer to a viewer than the liquid crystal cell is.

24 (Withdrawn). The liquid crystal display device of claim 16, wherein the first and second optical compensators are located more distant from a viewer than the liquid crystal cell is.

25 (Withdrawn). The liquid crystal display device of claim 16, wherein the first optical compensator is a phase film with uniaxial optical anisotropy.

26 (Withdrawn). The liquid crystal display device of claim 16, wherein the second optical compensator is a phase film with uniaxial optical anisotropy.

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27 (Withdrawn). The liquid crystal display device of claim 16, wherein the transmission axis of the other polarizer is either substantially parallel or substantially perpendicular to the orientation directions of the liquid crystal molecules in the black display state, the liquid crystal molecules being included in the liquid crystal layer and located near the substrate that is closer to the first optical compensator.

28 (Withdrawn). The liquid crystal display device of claim 16, wherein the liquid crystal layer has a twist angle of 85 degrees to 95 degrees.

29 (Withdrawn). A twisted nematic liquid crystal display device for conducting a display operation in Normally Black mode, the liquid crystal display device comprising

a liquid crystal cell including two substrates, a liquid crystal layer sandwiched between the two substrates, and two alignment layers provided on the two substrates so as to face the liquid crystal layer, and

two polarizers facing each other with the liquid crystal cell interposed between themselves,

wherein the liquid crystal display device further includes

a first optical compensator between one of the two polarizers and the liquid crystal cell, and

a second optical compensator between the first optical compensator and that polarizer,

wherein the liquid crystal layer has a front retardation $\Delta n \cdot d$ of 390 nm to 550 nm in the black display state, and

wherein each of the first and second optical compensators exhibits a retardation, and has a slow axis, within a plane that is defined parallel to the liquid crystal layer, and

wherein the first optical compensator has an in-plane retardation Re_1 of 75 nm to 210 nm, and the slow axis of the first optical compensator defines an angle of 85 degrees to 95 degrees with respect to orientation directions of liquid crystal molecules in the black display state, the liquid crystal molecules being included in the liquid crystal layer and located near one of the two

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substrates, which is closer to the first optical compensator, and

wherein the in-plane retardation R_{e2} of the second optical compensator and the front retardation $\Delta n \cdot d$ of the liquid crystal layer satisfy the inequality $0.44 \cdot (\Delta n \cdot d) + 50 \leq R_{e2} \leq 0.44 \cdot (\Delta n \cdot d) + 80$, and the slow axis of the second optical compensator defines an angle of 42 degrees to 48 degrees with respect to orientation directions of the liquid crystal molecules in the black display state.

30 (Withdrawn). The liquid crystal display device of claim 29, wherein the first and second optical compensators are located closer to a viewer than the liquid crystal cell is.

31 (Withdrawn). The liquid crystal display device of claim 29, wherein the first and second optical compensators are located more distant from a viewer than the liquid crystal cell is.

32 (Withdrawn). The liquid crystal display device of claim 29, wherein the first optical compensator is a phase film with uniaxial optical anisotropy.

33 (Withdrawn). The liquid crystal display device of claim 29, wherein the second optical compensator is a phase film with uniaxial optical anisotropy.

34 (Withdrawn). The liquid crystal display device of claim 29, wherein the transmission axis of the other polarizer is either substantially parallel or substantially perpendicular to the orientation directions of the liquid crystal molecules in the black display state, the liquid crystal molecules being included in the liquid crystal layer and located near the substrate that is closer to the first optical compensator.

35 (Withdrawn). The liquid crystal display device of claim 29, wherein the liquid crystal layer has a twist angle of 85 degrees to 95 degrees.

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36 (Withdrawn). A multilayer phase plate with a multilayer structure comprising a first layer and a second layer,

wherein each of the first and second layers has a slow axis, and exhibits a retardation, within a plane that is defined parallel to the layer, and

wherein the first layer has an in-plane retardation of 75 nm to 210 nm, and

wherein the second layer has an in-plane retardation of 220 nm to 320 nm, and

wherein the slow axis of the second layer defines an angle of 42 degrees to 48 degrees with respect to the slow axis of the first layer.

37 (Withdrawn). The multilayer phase plate of claim 36, wherein the slow axis of the second layer defines an angle of approximately 45 degrees with respect to the slow axis of the first layer.

38 (Withdrawn). The multilayer phase plate of claim 36, wherein the multilayer phase plate is used in a twisted nematic liquid crystal display device for conducting a display operation in Normally Black mode.